A SYSTEMATIC STUDY OF THE MAIN ARTERIES IN THE REGION OF THE HEART—AVES XVIII.

PSITTACIFORMES, PART I[1]

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It is important to point out that the nomenclature and species designation of many of the earlier writers, particularly those writing on avian morphology, have used names which cannot be truly identified in a great many instances, or only with considerable difficulty and uncertainty. Furthermore, due to more recent taxonomic studies, many species have been shifted from one family or even order to another and, in addition, many species and even genera have been regrouped within the orders.

A consideration of present taxonomic positions in view of anatomical evidences should aid in a better understanding of specific and family relationships. Important morphologic deviation of species within any genus should be adequate basis for reassignment of the aberrant forms.

Garrod (1873) has pointed out that among the Psittaciformes, a wide variety of arrangements of the carotid arteries can be observed. Garrod's species designations, however, do not always directly correspond with the names which are designated by Peters (1937). As a result, Garrod's identifications cannot be regarded as altogether accurate in light of present-day nomenclature. It will suffice, however, for discussions in which approximate species designations are satisfactory.[2]

Strigops habroptilus G. R. Gray, *Chalcopsitta cardinalis* (G. R. Gray) (*Lorius cardinalis*), *Eos histrio histrio* (P. L. S. Müller) (*Eos indica*), *Kakatoe roseicapilla roseicapilla* (Vieillot) (*Eolophus roseicapillus*), *Glossopsitta concinna* (Shaw) (*Trichoglossus concinnus*), *Nymphicus hollandicus* (Kerr) (*Calopsitta novaehollandiae*), *Prioniturus sp.*, *Psittacula krameri manillensis* (Bechstein), *Psittacula alexandri alexandri* (Linnaeus) (*Palaeornis alexandri*), *Psittacula cyanocephala cyanocephala* (Linnaeus), (*Aprosmictus scapulatus*) is probably *Alisterus scapularis scapularis* (Lichtenstein), *Agapornis roseicollis* (Vieillot), *Loriculus sp.* is (*Loricullus sp.*), *Neophema pulchella* (Shaw) (*Euphema pulchella*), *Neophema splendida* (Gould) (*Euphema splendida*), *Neophema bourkii* (Gould) (*Euphema Bourkii*), and *Melopsittacus undulatus* (Shaw) are reported to be "aves bicarotidinae normales" (2 & 3) with both left and right internal carotid arteries entering the hypapophysial canal (fig. 1).

In *Nestor notabilis* Gould, (*Nestor hypopolius*—correct accepted name as yet undetermined), *Lathamus discolor* (White), *Ara macao* (Linnaeus), *Aratinga holochlora holochlora* (Sclater) (*Conurus holochlorus*), *Aratinga jandaya* (Gmelin) (*Conurus jendaya*), *Aratinga canicularis canicularis* (Linnaeus) (*Conurus petzi*), *Pyrrhura cruentata* (Wied) (Conurus cruentatus), *Forpus passerinus flavissimus* Hellmayr (*Psittacula passerina*), *Brotogeris tirica* (Gmelin) (*Brotogerys tiriacula*), *Brotogeris versicolurus versicolurus* (P. L. S. Müller) (*Brotogerys virescens*), *Brotogeris chrysopterus tuipara* (Gmelin) is the probable designation for (*Brotogerys tui*), *Pionites melanocephala melanocephala* (Linnaeus) (*Caïca melanocephala*), *Pionus*

[1]Contribution of the Blue Sea Lake Biological Laboratory, Messines, P. Q.

[2]Generic and specific names followed by the authority's name are in accordance with "Check-list of Birds of the World," Vol. III, by J. L. Peters. Generic and specific names in brackets are those of Garrod (1873).

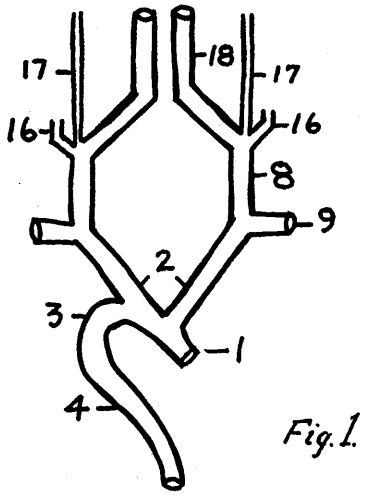


Fig. 1.

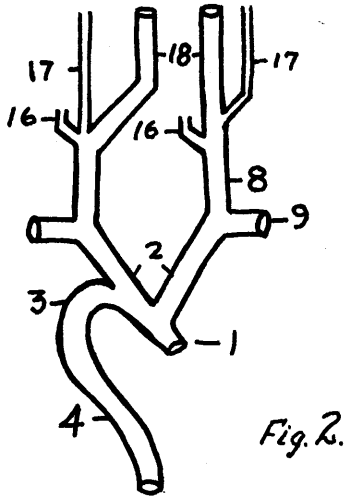


Fig. 2.

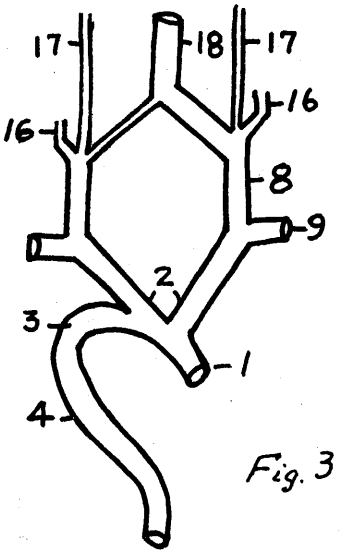


Fig. 3

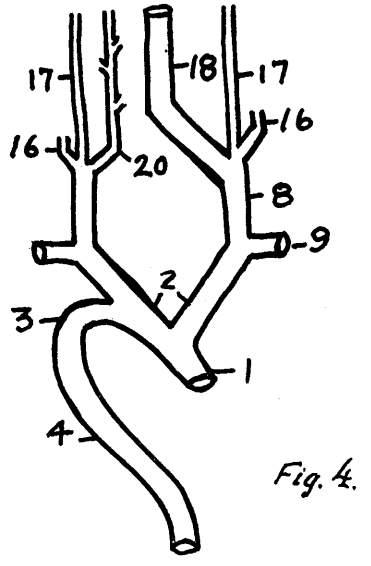
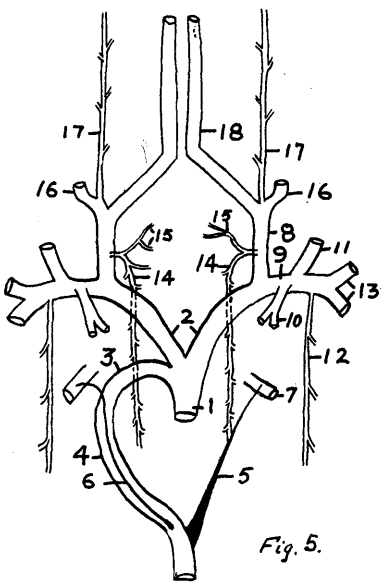
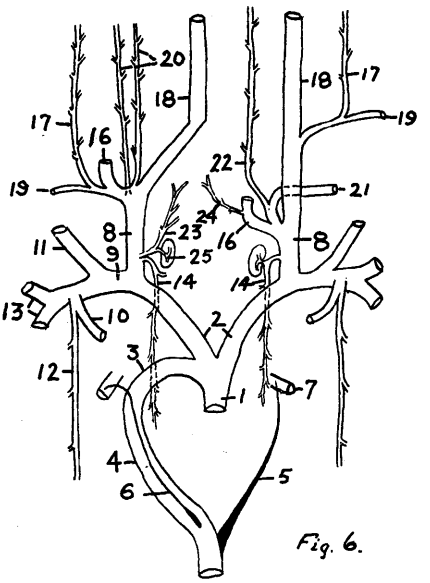


Fig. 4.

FIGURES 1–4. Ventral view of main arteries in neck and thorax.
FIGURE 1. "aves bicarotidinae normales"—*Melopsittacus undulatus.*
FIGURE 2. "aves bicarotidinae abnormales"—*Ara macao.*
FIGURE 3. "aves conjuncto-carotidinae" (modification)—*Kakatoe s. sulphurea.*
FIGURE 4. "aves laevo-carotidinae"—*Kakatoe sulphurea citrino-cristata.*
(Figures 2, 3, and 4 adapted, with modifications, after Garrod.)

menstruus (Linnaeus), *Amazona festiva festiva* (Linnaeus) (*Chrysotis festiva*), *Amazona ochrocephala oratrix* Ridgway (*Chrysotis levaillantii*), *Amazona ochrocephala ochrocephala* (Gmelin) (*Chrysotis ochrocephala*), (*Conurus xantholaemus*) is undetermined but is probably *Amazona ochrocephala xantholaema* Berlepsch, *Psittacus erithacus erithacus* Linnaeus, *Platycercus eximius eximius* (Shaw), *Platycercus adsciyus palliceps* Lear (*Platycercus pallidiceps*), *Northiella haematogaster haematogaster* (Gould) (*Psephotus haematogaster*), *Cyanoramphus novaezelandiae novaezalandiae* (Sparrman) (*Cyanorhamphus novae-zealandiae*), and *Cyanoramphus auriceps auriceps* (Kuhl) (*Cyanorhamphus auriceps*) the right internal carotid artery enters the hypapophysial canal while the left internal carotid artery is superficial and passes anteriorly along the left side of the neck (fig. 2), according to Garrod (1873).





FIGURES 5–6. Ventral view of main arteries in neck and thorax.
FIGURE 5. *Agapornis personata.*
FIGURE 6. *Ara ararauna.*

KEY TO NUMBERS IN FIGURES

1. aortic root; 2. innominate artery; 3. right systemic arch; 4. right radix aortae; 5. ligamentum aortae; 6. ligamentum botalli; 7. pulmonary artery; 8. common carotid artery; 9. subclavian artery; 10. coracoid major artery; 11. axillary artery; 12. intercostal artery; 13. pectoral arteries; 14. ductus shawi; 15. syringo-tracheal arteries; 16. vertebral artery; 17. superficial cervical artery; 18. internal carotid (trunk) artery; 19. scapular artery; 20. ascending oesophageal artery (right); 21. secondary axillary artery; 22. ascending oesophageal artery (left); 23. right basi-oesophageal artery; 24. left basi-oesophageal artery; 25. thyroid artery.

According to Garrod (1873), Meckel reported that the right internal carotid artery is very small and fuses with the left internal carotid in *Kakatoe sulphurea sulphurea* (Gmelin), with the vessel thus formed entering the hypapophysial canal and then passing anteriorly to the head. Such a condition is refered to as "aves conjuncto-carotidinae" (fig. 3) and is occasionally encountered in other orders of birds, especially in the Ciconiiformes (Glenny, 1945). Finally, Garrod reported that in *Kakatoe galerita galerita* (Latham) and *Kakatoe sulphurea citrino-cristata*

(Fraser) (*Cacatua cristata*) the left internal carotid artery alone enters the hypapophysial canal to carry the blood supply to the head (fig. 4).

The present study in part confirms some of the findings of Garrod, and adds further to our present knowledge of the arterial arrangements in the neck and thorax of birds.

An excellent study of the cervical and thoracic arteries in two species of parrots (*Psittacula c. cyanocephala* and *Psittacula krameri manillensis*) was carried out by Bhaduri and Biswas (1945). In this study, the writers found the two paroquets to be "aves bicarotidinae normales" and to present both the ligamentum aortae and ligamentum botalli, as well as left and right ascending oesophageal arteries. While this latter condition is not too frequently reported in the literature, it is undoubtedly present in a great many species of birds (Glenny, 1943–1948).

MATERIALS

Single specimens of *Vini australis* (Gmelin) (USNM #319754), *Ara ararauna* (Linn.) (ROMZ), *Brotogeris jugularis jugularis* (P. L. S. Müller) (USNM #343969), *Agapornis personata* Reichenow (USNM #290557), and *Melopsittacus undulatus* (Shaw) (USNM #322002) were studied. The specimens used in this study were obtained from the United States National Museum and the Royal Ontario Museum of Zoology.

OBSERVATIONS

Melopsittacus undulatus, *Agapornis personata*, and *Vini australis* are "aves bicarotidinae normales." The common carotid (8) gives rise to the ductus shawi (14) and then divides to give rise to the vertebral (16), superficial cervical (17), and internal carotid (trunk) arteries (18). The subclavian (9) gives rise to the coracoid major (10), axillary (11), intercostal (12), and two pectoral (13) arteries in order, in both *Melopsittacus* and *Agapornis*, while in *Vini* the axillary appears to arise medial to the coracoid major.

In *Agapornis* and *Vini*, both the ligamentum aortae (5) and the right ligamentum botalli (6) are present and prominent, while in *Melopsittacus* only the ligamentum aortae was observed to be present. The right superficial cervical artery (17) appears to serve as an ascending oesophageal artery.

Ara ararauna (fig. 6) and *Brotogeris jugularis* are similar in arterial arrangement in several respects. The right internal carotid (trunk) artery alone enters the hypapophysial canal, while the left carotid passes anteriorly and superficially along the left side of the neck. Both the ligamentum aortae and ligamentum botalli are present in *Ara*, while the ligamentum aortae alone was observed in *Brotogeris*.

The common carotid gives rise to the ductus shawi, the superficial cervical, and vertebral arteries before giving rise to the internal carotid (trunk) artery. The subclavian gives off the coracoid major, axillary, and two pectoral arteries in *Brotogeris jugularis*.

In *Ara*, the right common carotid sends off the ductus shawi, basi-oesophageal, superficial cervical, vertebral, ascending oesophageal, and internal carotid arteries; the left common carotid gives rise to the vertebral, superficial cervical, and superficial left internal carotid arteries. A scapular artery arises as a branch of the superficial cervical arteries on either side. The left vertebral artery gives rise to a secondary axillary artery (21), from the base of which vessel the left ascending oesophageal artery (22) arises, and a basi-oesophageal artery (24). The thyroid gland is supplied by a short thyroid artery which arises from the common carotid or one of its branches. The subclavian artery gives rise to the axillary, coracoid major, and two pectoral arteries in order. The intercostals (12) may arise from the coracoid major near its origin or from the subclavian just lateral to the coracoid major artery.

DISCUSSION

Beddard (1898) attempted to assign the Psittaciformes to two families on the basis of the arrangement of the carotid arteries, along with other major anatomical features. Except for the Cacatues or Kakatoes, the arrangement of subfamilies appears to fit into the anatomical arrangement fairly well, provided Beddard's criteria are employed. Peters' arrangement (1937), however, does not follow or correspond with the Beddard system. A comparison of the two taxonomic systems follows, and is accompanied by changes in generic names to correspond with Peters (1937).

BEDDARD	PETERS	Subfamily
Family I. PALAEORNITHIDAE (2 carotids enter hypapophysial canal):		
Subfamily 1. **Palaeornithinae**		
Palaeornis	*Psittacula*	**Psittacinae**
Eclectus	*Lorius*	"
Aprosmictus	*Psittacula*	"
Eos	*Eos*	**Loriinae**
Tanygnathus	*Tanygnathus*	**Psittacinae**
Prioniturus	*Prioniturus*	"
Psittinus	*Psittinus*	"
Loriculus	*Loriculus*	"
Trichoglossus	*Glossopsitta*	**Loriinae**
Lorius	*Domicella*	"
Sunfamily 2. **Cacatuinae**		
Calopsitta	*Nymphicus*	**Kakatoeinae**
Calyptorhynchus	*Calyptorhynchus*	"
Licmetis	*Kakatoe* (Subgenus *Licmetus*)	"
Eolophus	*Kakatoe* (Subgenus *Eolophus*)	"
Cacatua	*Kakatoe* (Subgenus *Kakatoe*)	"
Subfamily 3. **Stringopinae**		
Stringops	*Strigops*	**Strigopinae**
Euphema	*Neophema*	**Psittacinae**
Geopsittacus	*Geopsittacus*	"
Melopsittacus	*Melopsittacus*	"
Agapornis	*Agapornis*	"
Family II. PSITTACIDAE (left carotid is superficial; right carotid enters hypapophysial canal):		
Subfamily 4. **Arinae**		
Ara	*Ara*	**Psittacinae**
Conurus	*Aratinga*	"
Bolborhynchus	*Bolborhynchus*	"
Caïca	*Pionites*	"
Psittacus	*Psittacus*	"
Poeocephalus	*Poicephalus*	"
Nestor	*Nestor*	**Nestorinae**
Subfamily 5. **Pyrrhurinae**		
Pyrrhura	*Pyrrhura*	**Psittacinae**
Lathamus	*Lathamus*	**Loriinae**
Coracopsis	*Coracopsis*	**Psittacinae**
Pyrrhulopsis	*Prosopeia*	"
Subfamily 6. **Platycercinae**		
Platycercus	*Platycercus*	**Psittacinae**
Psephotus	*Psephotus*	"
Cyanorhamphus	*Cyanoramphus*	"
Psittacula	*Forpus*	"
Subfamily 7. **Chrysotinae**		
Chrysotis	*Amazona*	**Psittacinae**
Pionus	*Pionus*	"
Brotogerys	*Brotogeris*	"
add: *Vini australis* (aves bicarotidinae normales)		**Boriinae**

While in most orders of birds, both ordinal and family arrangement-patterns of the cervical and thoracic arteries can be observed, no single family pattern can be determined, and in so far as subfamily characteristics are concerned, based on Peters (1937), only the Strigopinae, Nestorinae, and Micropsittinae can be considered to offer any chance of characteristic arterial arrangement-patterns. Furthermore, the Kakatoeinae are reported to present at least three different arrangements of the carotid arteries alone (normal bicarotid, conjugate carotid, and "aves laevocarotidinae"). The Psittacinae likewise present wide variation in arrangement of the carotids, while the Loriinae present at least two major carotid arrangements.

As a result of the extreme complexity of structure in this order of birds, it is little wonder that they provide considerable difficulty in properly assigning group relationships. It is suggested that a reconsideration of this order be based more on skeletal structure, with particular emphasis on the bones of the skull and palate, musculature of leg and wings, and other soft viscera, including the aortic arch derivatives, as well as the other external features which are commonly used as bases for classification.

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